TECHNICAL REPORT
72-31-FL

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DEVELOPMENT OF COOKING PROCEDURES AND RECIPES FOR USING IRRADIATION STERILIZED MEATS

by

Agnes F. Carlin
Iowa State University
Ames, Iowa

Contract No. DA19-129-AMC-227(N)

January 1972

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

Food Laboratory
FL-72

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FOREWORD

The availability of shelf-stable, highly acceptable meat items for use in military feeding systems is considered a necessity. The currently available thermally processed items do not fully meet requirements because of their limited utility, stability and acceptability. Radiation processing, or "cold" sterilization as it is frequently called, has the potentiality of yielding products that have good military utility, good storage stability, and good acceptability. Therefore, research to develop recipes and methods for utilizing meats sterilized by ionizing radiation is underway.

The work covered in this report was performed by Iowa State University under Contract No. DA19-129-AMC-227(N) during the period from February 1964 to October 1966. It represents a series of studies to determine the acceptability of a number of meat items, prepared by a variety of recipes and cooking procedures, utilizing irradiated meats as their basic ingredient.

Dr. A. F. Carlin was the Project Officer and Official Investigator in the research work for Iowa State University. The U. S. Army Natick Laboratories Project Officer was Dr. F. Heiligman and the Alternate Project Officers were Dr. E. Wierbicki and C. E. Phillips, Major, QMC, both of the Food Laboratory. The work was conducted under Project 1K0-12501-A033, Radiation Preservation of Foods.

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ABSTRACT

Recipes were developed and procedures standardized for 15 food products containing irradiated pork, chicken, cured ham, or beef. Seventeen consumer panels composed of both men and women (1860 judgments) were employed to determine the acceptance of the irradiated meat products compared to similar products made with non-irradiated, precooked meat. It was found that browning irradiated meat in fat or long cooking with the other ingredients in the recipe reduced the "irradiation flavor." The use of onions, tomatoes, and spices enhanced the somewhat bland flavor of "warmed-over" meat.

Irradiated pork or chicken chop suey and pork, beef, or chicken cooked in barbeque sauce were highly acceptable and rated higher or as high in acceptability as non-irradiated meat in similar products. All 15 meat products tested received average acceptability scores of from 6.0 to 7.7 on a 9-point hedonic scale (9 = "like extremely"). Both trained laboratory panels and consumer panels were used to determine the effect of the various factors on the acceptance of the irradiated meat.

INTRODUCTION

During recent years the potential benefits to be derived from subjecting food to ionizing radiations have intrigued many investigators. Proctor and Goldblith (1951, U.S.A.) and Hannan (1955, England) reported that irradiation of food was an effective method of destroying the food spoilage organisms. When the problems of wholesomeness and storage stability are solved, the palatability and acceptability of irradiated meats are of paramount importance.

Characteristic changes occur in the organoleptic qualities of food preserved by ionizing radiations. The extent of the changes is related not only to the dose of radiation administered but also depends on the processing techniques, storage conditions, and reheating procedures that are used. Although many studies have been conducted on processing techniques, few studies have been made on reheating procedures and types of recipes that will mask any of the possible undesirable flavors that might occur in irradiated meats.

The objectives of this investigation were to determine optimum cooking procedures and to develop and prepare recipes for meat items using enzyme-inactivated radiation sterilized meats as the principal ingredient.

Meat treated with 4.5-5.6 megarads of Cobalt-60 radiation must be enzyme-inactivated prior to irradiation in order to make it shelf-stable. The customary method of inactivation is to heat the product for a short time to 75-77°C. However, this procedure results in a product that is substantially cooked. Thus, when the meat is reheated prior to serving, it has a "warmed-over" flavor that is not desirable. In addition, sterilizing doses of irradiation may produce objectionable odors or flavors. Hence the procedures evaluated in this study were specifically designed for either reducing or masking the odors and flavors found in "warmed-over" irradiated meats.

Two types of panels were used: small laboratory panels of experts in food evaluation and large consumer panels. The methods of evaluation, types of tests, and panels used were adapted to the specific objectives of each phase of the investigation. For evaluation of cooking procedures and development of recipes, a panel of 8 experts judged the meat products using either a triangle test or scoring with comments and suggestions for improvement. The acceptance of the irradiated meat recipes was indicated by consumers on a 1 to 9 hedonic scale (9=like extremely; 1=dislike extremely).

EXPERIMENTAL PROCEDURE

All the irradiated meat used in this investigation was processed by the personnel at the U. S. Army Natick Laboratories. Prior to irradiation all meat was heat-treated to inactivate enzymes. Then the meat was packed in tin cans and treated at ambient temperature with

4.5-5.6 megarads of Cobalt-60 radiations. Meat samples were stored at room temperature for approximately six months. Prior to organoleptic tests, each can of meat was tested for absence of Clostridium botulinum toxin using a standard biological assay with mice. (The investigators adhered to the "Principles of Laboratory Animal Care" as established by the National Society for Medical Research.) In addition, our laboratories prepared precooked meat (pork loins, chicken, or beef) for use as control samples. Thus the non-irradiated meat was completely cooked, cooled, stored in the refrigerator, and then added to the other ingredients at the time of preparing the recipes similar to those containing irradiated meat.

In the case of the cured hams, boneless rolled cured smoked hams were secured from Wilson and Co. in Omaha, Nebraska and this company also supplied the cured smoked hams for irradiation at the U. S. Army Natick Laboratories. Thus, the non-irradiated hams that our lab used and the irradiated hams received similar curing procedures.

Since previous investigators have reported that heating of the irradiated meat or browning the meat in fat often reduced irradiation odors, the first phase of the investigation (from September to December, 1964) was concerned with the effect of the time and temperature of heating irradiated meat and the use of fat in the preparation of the meat as well as the effect of the ingredients on the flavor of the final product.

Laboratory panels

A laboratory panel of 12 judges (4 men and 8 women) was selected from among the students and staff at Iowa State University. Factors considered in the selection were: 1) ability to detect differences between samples of irradiated and non-irradiated pork and chicken, 2) high acceptance of Pork Chop Suey and Chicken Barbeque, 3) interest in the project, and 4) availability for test sessions scheduled at noon. Since the objective was to determine if panel members could detect differences in flavor caused by variations in methods of heating the meat, the triangle test method was used to evaluate the samples.

In the triangle test three smaples were presented, two were duplicates, and the panel member was asked to indicate which sample was different from the other two. In this study, judges were asked also to indicate which sample or samples they preferred. Serving order of the three samples in each test, i.e., AAB, ABA, BAA, BAB, or ABB, was selected at random. However, for certain tests the position was predetermined so that a non-irradiated sample was not tasted after an irradiated sample. Judges were instructed to taste samples in the order that the code numbers appeared on their score cards. Two triangle tests were conducted each day. General appearance and odor of the samples were evaluated by persons preparing the food. Results of these observations and the triangle tests were used in the selection of a final procedure.

Upon arrival at 12:00 noon, panel members were directed to judging booths in which the physical conditions such as temperature and lighting were carefully controlled. Red lights were used to mask any differences in appearance of meat samples. Cooking odors and noise in the panel areas were kept to a minimum. Each judge was provided with a glass of water, sheets that explained sensory difference tests in general with emphasis on the triangle test, and two triangle test score cards. Panel members were served hot, coded samples in white preheated sauce dishes. Each sample (approximately 30 g) contained a minimum of four pieces of meat.

The variables tested for the method of reheating the irradiated pork or chicken for the chop suey or barbeque included: browning pork loin in fat or not browning it and adding the pork to the other ingredients at the beginning or at the end of cooking the chop suey; steaming or not steaming the chicken prior to adding to the barbeque sauce, and adding the chicken to the other ingredients at beginning or end of cooking the barbeque sauce. Also the toal time of cooking the meat and other ingredients was varied. A summary of the procedures tested follows:

1. Treatment of meat alone:

   Pork loin cubes not browned
   Pork loin cubes browned in fat at 171°C for 4 min or 8 min
   Chicken cubes (from breast or thigh meat) steamed 0, 5, or 10 min

2. Time of adding meat to other ingredients:

   At the beginning or near the end of the cooking period

3. Length of cooking period:

Pork Chop Suey, 21, 23, 25, 27, and 31 min
Chicken Barbeque, 40 or 60 min

Results from the above experiments using triangle tests with a laboratory sensory-difference panel and observations made by persons preparing the foods were used in the selection of the method used in the preparation of the Pork Chop Suey or Chicken Barbeque. A combination of browning the irradiated pork loin in fat plus simmering it with the other ingredients for 50 to 60 min resulted in a product that the laboratory panel could not distinguish from chop suey made in a similar way with non-irradiated pork loin.

Results from the triangle tests with Chicken Barbeque indicated that there were no detectable differences between irradiated chicken that was steamed or not steamed prior to adding it to the other ingredients. Also cooking the chicken and sauce for 60 min, improved the flavor.

After December 1964, the method used for development of cooking procedures and recipes was changed somewhat as a group of ten staff and graduate students in food science evaluated the products. These individuals had considerable experience in tasting and evaluating foods. The procedure followed was to have round table discussion during the initial stages of developing a new product. Then regular scheduled taste panel sessions were held, in which characteristics were scored and comments or suggestions for improvement were written. All changes in a recipe were evaluated by the panel and a

recipe was not released for the acceptance tests by the consumer panels until it received a favorable rating by the members of the laboratory panels. A number of products were tested and rejected. The meat recipes that were tried but did not appear to have potential for use with irradiated meats are listed in Table 1.

Four products were evaluated by the laboratory panel in the spring of 1966. Procedures and recipes were developed and these products were considered ready for submitting to consumer panels for acceptance studies. However, the contract terminated in September 1966, and the products: Hot Beef Sandwich, Jiffy Steaks, Beef and Vegetable Stew, and Beef Goulash were not tested for acceptance. However, the four recipes are included in this report.

Table 1. Recipes tried but not used

Pork

Pork Slices in:
- Creole sauce
- Brown gravy
- Brown onion gravy
- Tomato gravy

Pork Cubes, Cream Gravy with Rice

Chicken

Broiled Chicken with butter glaze
Broiled Chicken marinated in:
- Lemon juice
- Barbeque sauce
- Buttermilk
- French dressing

Creamed Chicken
Chicken and Gravy
Chicken A La King
Fried Chicken with Assorted Coatings

Ham

Broiled Ham Slices
Ham slices marinated in:
- Soy sauce and ginger
- Vinegar, sugar, and mustard
- French dressing

Ham and Chunk Pineapple
Ham and Cheese Sandwich
Baked Ham Roll with Cherry Glaze

Ham Sauces

Savory Cranberry Sauce
California Raisin Sauce
Apricot Sauce
Pineapple Mustard Sauce
Cranberry Orange Sauce
Cherry Sauce
Mustard Horseradish Sauce

Pineapple Apricot Sauce
Light Raisin Sauce
Apricot Raisin Sauce
Apricot Orange Sauce
Apricot Honey Sauce
Tangerine Sauce
Brown Sugar Sauce
Cherry Preserve Glaze

Beef

Spiced Beef Cubes
Chili Casserole
Tamale Pie
Beef Stroganoff
Meat Ball Stroganoff
Hamburger Stroganoff
Gravy and Hot Beef Sandwiches

Porcupine Meatballs
Saurbraten
Swedish Meatballs
Chili Con Carne with Cornbread Topping
Beef in Soy Sauce and Anise
Beef with Sour Cream Sauce

HOT BEEF SANDWICH

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Fat	46.0	Beef broth soup, condensed	1-10 1/2 oz. can
Flour, unsifted	25.0	Minced instant onion	3.0
Water, tap, boiling	1 cup	Salt, plain	1.0
Wilson's B-V	16.0	Pepper, black	0.1
Kitchen Bouquet	2.5	Flour, unsifted	15.0
Brown sugar, light	7.0	Water, tap, cold	125.0
		Meat, sliced	200.0

Procedure for making gravy in heavy 3 qt aluminum sauce pan: Melt fat (66°C) and stir in flour gradually until smooth. Add water (boiling), stirring constantly. Stir until flour mixture thickens. Reduce temperature to 93°C[a] Boil starch mixture for 1 min, stirring constantly. Add Wilson's B-V. Mix till even in color. Add Kitchen Bouquet, brown sugar and beef broth (minced onions should be added to the beef broth before starting the gravy to hydrate them). Add spices. Set temperature at 149°C. Bring to a boil and boil 1 min. Stir occasionally (do not stir too much or the gravy will become runny). Make paste from flour and cold water. Add gradually to the saucepan stirring constantly. Turn temperature to high and boil 1 min.

Add sliced meat and lower heat to 66°C. Heat for at least 15 min. Serve over 1/4 slice of white bread.

Servings: 10 sample size

[a]Temperature given are for Sensi-temp burner on a Roper gas range.

JIFFY STEAKS

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Minced instant onion	1.5	Mustard, prepared	2.5
Red wine vinegar	30.0	Butter	25.0
Water, cold, tap	15.0	Tomato sauce	80.0
Salad oil	110.5	Minced instant onion	1.5
Worcestershire sauce	26.0	Cheese, sharp	10-1/4 in slices
Salt, seasoned	5.5	Hamburger buns	1/4 / person
Pepper, black	0.1	Butter, melted	25.0
Meat, sliced	200.0	Salad oil (for electric frypan)	15.0

Soaked minced instant onion in vinegar and water 5 min. Add salad oil, Worcestershire sauce, seasoned salt, and pepper and blend well. Arrange meat in single layer in cake pan and pour vinegar marinade over it. Cover with aluminum foil and place in refrigerator for 1 1/2 hr. Butter buns and toast in 121°C oven for 5 min. Set frypan for 193°C and add salad oil and heat 2 min. Place marinated meat in frypan and fry 1 1/2 min. Turn and fry 1 min more. Place meat on bun. Hydrate minced onion in tomato sauce 15 min. Spread meat surface with mustard-butter mixture and thinly spread tomato-minced onion mixture on top. Place 1/4 slice sharp cheese over tomato mixture. Warm at 121°C for 3 min.

Servings: 10 sample size

BEEF AND VEGETABLE STEW

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Flour, unsifted	25.0	Accent	1.00
Fat	46.0	Water, tap, boiling	125.0
Water, tap, boiling	1 cup	Worcestershire sauce	5.70
Wilson's B-V	16.0	Salt, seasoned	1.20
Kitchen Bouquet	2.5	Salt, plain	1.15
Brown sugar, light	7.0	Pepper	0.35
Instant minced onion	4.0	Carrots, sliced	180.00
Beef broth soup, condensed	1-10 1/2 ox. can	Potatoes, cubed	290.00
		Onions, sliced	130.00
Celery salt	0.5	Meat, cubed	272.00
Onion salt	0.5		

Hydrate minced onion in beef broth for 15 min. Add fat to deep fat fryer and heat at 149°C for 1 min. Add flour gradually to melted fat, stir until consistency is smooth. Add boiling water, stir until mixture thickens. Boil at rolling boil 1 min. Lower temperature to simmer and add B-V, Kitchen Bouquet, brown sugar, beef broth, and spices. Set temperature at 149°C. Bring to a rolling boil and boil 1 1/2 min. Stir occasionally. Add 125g boiling water. Reduce temperature to simmer; add carrots, onions, and potatoes. Simmer 1 hr 10 min. Add meat cubes and simmer 15 min. Add flour to cold water to make paste. Add paste to stew and boil at 135°C for 1 min.

Servings: 15 sample size

BEEF GOULASH

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Beef broth soup, condensed	250	Oregano	0.1
Tomatoes, canned	560.5	Thyme	0.1
Onion, diced	125.0	Cinnamon	0.1
Tomato puree	265.0	Celery salt	0.2
Tomato catsup	50.0	Accent	0.2
Salt	3.0	Meat, cubed	300.0
Pepper	0.2	Macaroni	200.0
Onion salt	0.4	Water (to boil macaroni)	6000.0

Put fat in an electric frypan and heat at 193°C for 2 min. Saute' onions 4 min at 193°C. Add tomatoes, tomato catsup, and seasonings. Simmer 20 min on warm setting. Add cubes of meat, simmer 20 min at 104°C. Boil macaroni for 2 min. Cover and let stand 9 min. Drain and add to tomato mixture.

Servings: 10 sample size

Consumer panels

Consumer acceptance of products containing radiation sterilized pork loin, chicken breast and thighs, cured ham, and beef loins or rounds was determined by individual responses on a 9-point hedonic rating scale. Panels of approximately 20 men and 20 women per panel were selected from single or married under-graduate students at Iowa State University. One person from each group, a chairman, was contacted and given an instruction sheet and an explanation of the financial arrangements. The chairman distributed a one-page description of the project to prospective panel members and recruited students for the panels.

Each prospective consumer panel member completed a questionnaire regarding preferences for 35 or 50 foods and a questionnaire on background information. On the basis of the information from the completed forms, students were eliminated who: 1) indicated poor health or failed to indicate health status; 2) indicated "not tried" or from "dislike slightly" to "dislike extremely" for the products being tested; or 3) failed to indicate a preference for the products being tested.

A list of the names of selected consumer panel members and qualified substitutes plus instructions for consumer panel members were sent to the chairman. From the list of qualified consumers, a certain number of persons (usually 20) agreed to attend two tasting sessions (in some cases three). During the investigation 680 people served on 17 consumer panels.

Panel members were asked to refrain from eating, smoking, gum chewing, or drinking (anything but water) for one hour before the tasting session. Two rooms were arranged for the consumer panel sessions. Physical conditions of the rooms were kept as similar as possible. Panel members arrived at 12:00 noon and were directed to the assigned rooms. In most cases the men were assigned to one room and the women to the other. In each room, a person in charge gave instructions and answered any questions. A glass of water, a test direction sheet, and two score cards were provided for each person. The score cards had spaces for consumers to check one of the nine hedonic ratings from "like extremely" to "dislike extremely." Consumers were also encouraged to write comments. It should be noted, that although the consumers had been informed that some of the samples would contain radiation sterilized meat, they had no knowledge of the treatment or of identity of either radiation sterilized or non-irradiated samples or when each sample was served.

Samples tested

The irradiated meat was packed in #3 or #10 cans and information regarding dosage and date of processing was written on the cans (with two exceptions). A description of all meat used in the products submitted to the consumer panels is given in Table 2.

The procedure and ingredients for 15 different meat products were developed using the laboratory panel described previously. The

Table 2. Summary of information on radiation sterilized meat samples used for consumer panels.

Panel no.	Date of test panel	Meat	Can size	No. of cans	Code	Mrad	Process date
1,2	Dec. 7-10 1964	Chicken Breast	#10	2	64/64B	4.5-5.6	June '64
		Chicken Thigh	#10	2	64/64T	4.5-5.6	June '64
		Pork Loin	#10	3	64/60	4.5-5.6	June '64
3,4	Dec. 14-17 1964	Chicken Breast	#10	1	64/64B	4.5-5.6	June '64
		Chicken Thigh	#10	1	64/64T	4.5-5.6	June '64
		Pork Loin	#10	1	64/60	4.5-5.6	June '64
5,6	Jan. 11-14, 1965	Chicken Breast	#10	1	64/64B	4.5-5.6	June '64
		Chicken Thigh	#10	2	64/64T	4.5-5.6	June '64
		Pork Loin	#10	2	64/60	4.5-5.6	- - - - -
7,8	Jan. 18-21, 1965	Chicken Breast	#10	1	64/64B	4.5-5.6	June '64
		Chicken Thigh	#10	1	64/64T	4.5-5.6	June '64
		Pork Loin	#10	2	64/60	4.5-5.6	June '64
9	March 23-25, 1965	Cured Ham	#10	3	64/122	2.5-3.1	Dec. '64
		Chicken Breast	# 3	8	64/121	4.5-5.6	Dec. '64
10	March 30- April 1, 1965	Cured Ham	#10	3	64/122	2.5-3.1	Dec. '64
		Chicken Breast	# 3	8	64/121	4.5-5.6	Dec. '64
11	April 6-8, 1965	Cured Ham	#10	3	64/122	2.5-3.1	Dec. '64
		Chicken Breast	# 3	7	65/14	4.5-5.6	Feb. '65
		Chicken Breast	# 3	2	65/12	4.5-5.6	--------

Table 2. (Continued)

Panel no.	Date of test panel	Meat	Can size	No. of cans	Code	Mrad	Process date
12-14	Oct. 12, 14 & 19-21, 1965	Cured Ham	#10	7	65/30	4.5-5.6	April '65
15,16	Dec. 7-10, 1965	Beef Round	# 3	9	65/80	4.5-5.6	Oct. '65
17	Dec. 14,16 1965	Beef Round	# 3	3	65/80	4.5-5.6	Oct. '65

products tested for acceptance by the 17 consumer panels were:

Pork Chop Suey
Pork Barbeque
Chicken Chop Suey
Chicken Barbeque
Ham Slices
Ham Slices, Fruit Sauce
Chicken Salad, not marinated
Chicken Salad, cold marinade
Chicken Salad, hot marinade
Creamed Ham Carolina
Montaug Sandwich (Ham)
Sweet and Sour Ham
Barbeque Beef
Beef and Gravy on Noodles
Chunk Chili

The recipes for the 15 products are given on pages 18-26.

PORK CHOP SUEY

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Pork, boneless loin cubes, 3/4 in.	500.00	Onions, sliced	400
Salt	8.00	Celery, sliced	200
Pepper	0.15	Bean sprouts	200
Shortening	48.00	Bean sprout liquid	100
Cornstarch	40.00	Water	100
Water	1000.00	Soy sauce	40
		Molasses	8

Add shortening to the electric skillet and heat for 3 min at 171°C. Add cubed pork loin to the skillet, sprinkle with salt and pepper, and brown for 8 min. Turn cubes every 2 min. Add water (1000 g), onions, and celery to mixture and reduce heat to 110°C. Boil mixture gently for 15 min in covered skillet. Mix bean sprout liquid and water with the cornstarch, add to the hot mixture, and cook, uncovered, for 3 min. During the cooking period, stir the mixture 50 strokes. Add the bean sprouts, soy sauce, and molasses. Stir the mixture 20 strokes. Reduce heat to 104°C and simmer for 5 min.

Date Served: Dec. 7-17, 1964 Servings: 20 sample size

PORK BARBEQUE

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Pork, boneless loin strips	750.0	Sugar	154.50
Mustard, prepared	22.5	Salt	32.25
Tomato paste	379.5	Pepper, black	0.75
Vinegar	106.5	Cloves, ground	0.37
Water	500.0	Allspice, ground	0.75
Onions, ground	126.0	Chili powder	0.45
Celery, ground	126.0	Shortening	40.00

Combine all non-meat ingredients in a large bowl and beat 150 strokes with a rotary beater. Heat the shortening in an electric skillet for 3 min at 110°C. Add pork loin strips (1 1/2 x 1/2 x 1/4 in.) and heat for 15 min. Remove the pork strips and set aside. Add the sauce mixture to the skillet, cover, and simmer for 30 min at 110°C. Add the pork to the sauce and simmer the mixture an additional hr at 110°C.

Date Served: Jan. 11-21, 1965 Servings: 20 sample size

CHICKEN CHOP SUEY

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Chicken, cubed 3/4 in.	500.00	Celery, sliced	200
Salt	8.00	Bean sprouts	200
Pepper	0.15	Bean sprout liquid	100
Shortening	48.00	Water	100
Water	850.00	Soy sauce	60
Cornstarch	40.00	Molasses	8
Onions, sliced	400.00		

Preheat shortening in electric frypan for 3 min at 110°C. Sprinkle salt and pepper on chicken and heat 15 min in shortening, turning the meat every 2 1/2 min. Add 850 g water, celery, and onions. Cover pan and boil mixture gently for 15 min. Combine cornstarch with bean sprout liquid plus 100 g water and add to hot mixture. Cook chop suey mixture uncovered for 3 min stirring 50 strokes. Add bean sprouts, soy sauce, and molasses and stir 20 strokes. Reduce temperature to 104°C and simmer 5 min.

Date Served: Jan. 11-21, 1965 Servings: 20 sample size

CHICKEN BARBEQUE

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Chicken, cubed, 3/4 in.	750.0	Celery, ground	126.00
Tomato paste	379.5	Sugar	154.50
Vinegar	106.5	Salt	32.25
Mustard	22.5	Pepper, black	0.75
Water	600.0	Cloves, ground	0.38
Onions, ground	126.0	Allspice, ground	0.75
		Chili powder	0.45

Make the barbeque sauce the morning that the products are tobbe evaluated. Combine all the ingredients (except the chicken) in a bowl and mix with a rotary beater 150 strokes. Simmer the barbeque sauce in an electric frypan at 104°C for 40-60 min. Add the meat and simmer the mixture for 1 hr at 110°C.

Date Served: Dec. 7-17, 1964 Servings: 20 sample size

HAM SLICES

Insert meat thermometer in center of ham roll. Place in a pyrex loaf dish, but do not cover. Heat ham roll in a 163°C oven. When internal temperature reaches 54°C, remove from oven. Cut the ham roll in half, cut 1/4 inch thick slices, discarding end slices. Serve one half slice per person. Place 25 slices in prewarmed pyrex dish, cover and put in oven 135°C until served.

Date Served: Mar. 23 - Apr. 18, 1965 Servings: 25 sample size

HAM-FRUIT SAUCE

Prepare the ham slices as stated in the above recipe. Then pour (approximately 2 tablespoons) fruit sauce over the ham just before serving.

FRUIT SAUCE

Ingredient	Amt. (g)
Apricot nectar	750
Orange juice concentrate, frozen	120
Cornstarch	30
Brown sugar	75
Cloves, whole (remove after cooking)	3

Combine apricot nectar, orange juice, brown sugar, and cloves in a double boiler. Stir to dissolve sugar. Bring to simmer, cover and simmer for 1 1/2 hr. Strain out the cloves. Add cornstarch and heat until thickened and translucent, stirring constantly. Keep warm until served. A pyrex saucepan and a teflon spoon should be used to avoid possible metallic taste.

Date Served: Mar. 23 - Apr. 18, 1965 Servings: 45-50 sample size

CHICKEN SALAD*

Ingredient	Amt. (g)
Chicken (3/4 in. x 1/2 in.)	1310.0
Mayonnaise, chilled	650.0
Apple cider vinegar	50.0
Prepared mustard, chilled	35.0
Salt	15.0
Pepper, white	2.5
Celery, chopped	625.0

Weigh mayonnaise into large glass bowl. Add vinegar and mix until smooth. Add mustard, mix until combined, stir in salt and pepper. Mix ingredients with a teflon spoon and store in a covered qt. jar in refrigerator at least 3 days. Approximately 45 min prior to serving, place chicken and celery in two glass bowls, add 1/2 of dressing to each bowl and mix. Cover and return to refrigerator until served.

Date Served: Mar. 23 - Apr. 18, 1965 Servings: 40 sample size

*No marinade

CHICKEN SALAD, COLD MARINADE

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Chicken	1310.0	Dressing	
Celery, chopped	625.0		
		Mayonnaise	650.0
Marinade		Salt	15.0
		Pepper, white	2.5
Lemon juice	472 mls.	Prepared mustard,	
Water, tap	878 mls.	chilled	35.0

Weigh mayonnaise into a large glass bowl, add mustard, salt and pepper. Mix with a teflon spoon. Transfer dressing to a qt, glass jar, cover, and store at refrigerator temperature for at least 3 days. On the day before serving the chicken salad, mix marinade ingredients together. Place chicken and marinade mixture in a long flat pyrex pan, cover, and place in refrigerator overnight. The next day drain for 2 1/2 hr in a plastic strainer in the refrigerator. Approximately 45 min prior to serving salad, place marinated chicken and celery in two bowls. Add 1/2 of dressing to each bowl and mix. Cover and return to refrigerator until served.

Date Served: Mar. 23 - Apr. 18, 1965 Servings: 40 sample size

CHICKEN SALAD, HOT MARINADE

Recipes for Marinade and Dressing are the same as for Chicken Salad, cold marinade.

Place chicken and marinade mixture in pyrex saucepan, cover, heat until mixture boils gently. Continue heating for 5 min. Place chicken and marinade in glass dish, cover and store in refrigerator overnight. The next day drain in plastic strainer for 2 1/2 hr in the refrigerator. Mix chicken, celery, and dressing in large glass bowl approximately 45 min prior to serving, cover and return to refrigerator until served.

Date Served: Mar. 23 - Apr. 18, 1965 Servings: 40 sample size

CREAMED HAM CAROLINA

Ingredient	Amt. (g)
Ham, cubed	375
Mushroom soup, condensed	2-10 1/2 oz cans
Whole milk	240
Eggs, hard boiled	3
Bread, sandwich	6 slices

Heat soup and milk in double boiler, stir until fairly smooth. When temperature reaches 49°C, add ham. Heat until temperature reaches 80°C. Keep covered except when checking temperature. Serve one spoonful over toast point in warmed panel dish, garnish with one slice of hard cooked egg.

Date Served: Oct. 12, 14, 18, & 20, 1965 Servings: 20 sample size

MONTAUG SANDWICH (HAM)

Ingredient	Amt. (g)
Ham	48 slices, 30 g each
Cheese, sharp cheddar, grated	720.0
Dry mustard	7.0
Paprika	5.0
Salt	15.0
Pepper, cayenne	0.1
Worcestershire sauce	18 ml
Bread, white, regular	24 slices
Margarine, melted	56.8

Grate cheese, weigh, add weighed spices, and stir 30 strokes. Pipette in Worcestershire sauce and mix 20 strokes. This mixture may be stored overnight, or prepared as needed. Bring to room temperature to use. Slice ham roll into 1/4 in. slices and cut in half. Place bread, cut in half, on a pan, and brush with melted margarine. Spread about 30 g of sauce on each 1/2 slice of bread and top with a slice of ham. Bake 10 min in 213°C ovens.

Date Served: Oct. 12, 14, 19, & 21, 1965 Servings: 48 sample size

SWEET AND SOUR HAM

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Ham, cubed	700	Cottonseed oil	50.0
Carrots, sliced	200		
Onion, sliced	200	Sauce:	
Green pepper, sliced	150	Cornstarch	42.5
Pineapple chunks		Vinegar	107.5
drained	550	Bouillon	12.5
Pineapple juice	125 ml	Sugar	46.0
Water for vegetables	2 1/2 cups 625g	Soy sauce	22.5 ml

Cut ham in 1/2 in. cubes and slice carrots diagonally to give elongated slices. Cut peppers in 1/4 in. wide rectangular strips. Drain pineapple in plastic strainer, cut onion in thin slices and cut in half. About 1/2 hr before serving time, brown onions and ham in oil for 6 min in electric frypan, stirring constantly. Also start precooking vegetables. Precook carrots and pepper in water 12 min and discard water. In a separate bowl combine cornstarch and sugar. Add to this mixture vinegar, bouillon, and soy sauce and stir. Add pineapple, juice, cooked peppers, and cooked carrots to onions and ham. Reduce temperature to simmer, add sauce mix and cook until thickened and translucent. Cover and keep warm until served.

Date Served: Oct. 18-21, 1965 Servings: 20 sample size

BEEF BARBEQUE

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Meat, cubes, 3/4 in.	750.0	Sugar	154.50
Tomato paste	379.5	Salt	32.20
Apple cider vinegar	106.5	Pepper, black	0.75
Mustard, prepared	22.5	Cloves	0.38
Water, tap	600.0	Allspice	0.75
Onions, ground	126.0	Chili powder	0.30
Celery, ground	126.0		

Combine all ingredients for sauce and stir with a hand rotary beater for 150 strokes. Preheat electric skillet at 104°C for 3 min. Add combined ingredients for sauce and then meat to the preheated skillet. Cover and simmer for 1 hr at 110°C, stirring occasionally.

Date Served: Dec. 7, 9, 14, & 16, 1965 Servings: 20 sample size

BEEF AND GRAVY ON NOODLES

Ingredient	Amt. (g)
Beef, cubes, 3/4 in.	750
Flour	50
Fat	92
Water, tap	250
Wilson's B-V	32
Brown sugar, light	18
Kitchen Bouquet	5
Onion soup, condensed	2-10 1/2 oz cans

Melt fat and stir in flour; add water, stirring constantly. Bring mixture to a good boil. Add Wilson's B-V and stir constantly until gravy thickens. Add Kitchen Bouquet, onion soup, and brown sugar; bring mixture to a boil again, stirring occasionally (do not stir too much or gravy will become runny). Add cubed meat and lower heat. Heat for at least 15 min. Serve over hot noodles.

Date Served: Dec. 7-10, 1965 Servings: 20 sample size

CHUNK CHILI

Ingredient	Amt. (g)	Ingredient	Amt. (g)
Beef, 1/4 in. cubes	750.0	Paprika	0.80
Fat	63.0	Pepper, cayenne	0.15
Peppers, green, ground	150.0	Garlic powder	3.75
Onions, ground	450.0	Bay leaf	0.25
Tomato paste	300.0	Chili powder	9.00
Tomatoes, canned	855.0	Chili beans	750.00
Salt	8.1		
Sugar	24.0		

Make the chili sauce on the day before serving. Melt fat for 3 min at 135°C in electric frypan. Add ground green pepper and onions then brown for 4 min. Add tomatoes, spices and tomato paste. Cover and simmer for at least 1 hr. Remove bay leaf, transfer sauce to jar, cover and store in refrigerator overnight. On the day of serving, place the sauce in frypan, add meat to sauce; cover and simmer for 20 min. Add beans; cover and simmer 15 additional min.

Date Served: Dec. 8, 10, 14, & 16, 1965 Servings: 20 sample size

Preliminary experiments established the work schedule for each product. The time required for preparation of ingredients, cooking the product, and time between end of cooking and serving the panel were standardized. Since order of serving the samples could affect the individual's choice, the experimental design for each panel determined whether product A was served before or after product B, i.e. the order was not the same for the 17 panels.

In Table 3, a summary is given of the treatment of the meat served to each of the 17 panels and the order of serving for the 37 panel sessions held.

Consumers on panels 1-8 evaluated foods at two sessions on alternate days. Thus a total of 16 sessions were scheduled between December 7, 1964, and January 21, 1965, in which 306 consumers participated, (155 men, 151 women). At each first test session, the consumer panel was served portions of chop suey or barbeque made with non-irradiated meat; at the second test session, samples made with radiation sterilized meat were served. Since it was considered important to vary the order of service, the experimental design provided that chop suey or barbeque was served first an equal number of times during the 16 sessions (Table 3).

Consumers on panels 9-11 evaluated foods at three sessions on three consecutive days. In the 9 sessions scheduled between March 23 and April 8, 1965, 125 consumers, 87 men and 38 women participated. Married veterinary students and their wives (10 men, 11 women) were

Table 3. Summary of samples served to consumer panels.

Panel no.	Day	Treatment of meat	Product and order of serving
1 and 2	1	non-irradiated	Pork Chop Suey, Chicken Barbeque
	2	radiation sterilized	Pork Chop Suey, Chicken Barbeque
3 and 4	1	non-irradiated	Chicken Barbeque, Pork Chop Suey
	2	radiation sterilized	Chicken Barbeque, Pork Chop Suey
5 and 6	1	non-irradiated	Chicken Chop Suey, Pork Barbeque
	2	radiation sterilized	Chicken Chop Suey, Pork Barbeque
7 and 8	1	non-irradiated	Pork Barbeque, Chicken Chop Suey
	2	radiation sterilized	Pork Barbeque, Chicken Chop Suey
9,10, 11	1	radiation sterilized	Chicken Salad, cold marinated
		non-irradiated	Ham Slice
	2	radiation sterilized	Chicken Salad, not marinated; Ham slice, fruit sauce
	3	radiation sterilized	Chicken Salad, hot marinated; Ham Slice
12	1	non-irradiated	Montaug Sandwich, Creamed Ham Carolina
	2	radiation sterilized	Montaug Sandwich, Creamed Ham Carolina
13	1	non-irradiated	Creamed Ham Carolina, Sweet-Sour Ham
	2	radiation sterilized	Creamed Ham Carolina, Sweet-Sour Ham
14	1	non-irradiated	Sweet-Sour Ham, Montaug Sandwich
	2	radiation sterilized	Sweet-Sour Ham, Montaug Sandwich

Table 3. (Continued)

Panel no.	Day	Treatment of meat	Product and order of serving
15	1	non-irradiated	Beef and Gravy on Noodles, Barbequed Beef
	2	radiation sterilized	Beef and Gravy on Noodles, Barbequed Beef
16	1	non-irradiated	Beef and Gravy on Noodles, Chunk Chili
	2	radiation sterilized	Beef and Gravy on Noodles, Chunk Chili
17	1	non-irradiated	Chunk Chili, Barbequed Beef
	2	radiation sterilized	Chunk Chili, Barbequed Beef

among the 125 individuals in this part of the investigation. Only irradiated chicken was used for the chicken salad and the comparisons made were among hot marinade, cold marinade and no marinade. Irradiated and non-irradiated ham samples were used. Samples of chicken salad were served first and ham slices second at a given taste session. The order of serving and samples used for each panel are given in Table 3.

Consumers on panels 12-14 evaluated foods at two sessions held on alternate days. A total of 6 sessions were scheduled between October 12 and October 21, 1965, with 125 consumers participating (64 men, 61 women). The order of serving and samples used for each panel are given in Table 3.

Consumers on panels 15-17 indicated their acceptance at 2 sessions on alternate days. In the six sessions between December 7 and December 16, 1965, 124 consumers, (63 men, 61 women) participated. Beef and Gravy on Noodles was always served first because of its bland nature. The order of serving and samples used for each panel are given in Table 3.

RESULTS

All of the irradiated meat was tested for absence of Clostridium botulinum toxin using a standard biological assay with mice. Tests were made by an independent laboratory, Pharmatox Laboratories in Ames. The results on the 139 cans of meat were all negative, i.e. no evidence of toxin was found. Samples tested and results obtained are summarized in Table 4.

Table 4. Summary of samples tested and results of biological assays by Pharmatox Laboratory.

Meat sample	Can size no.	Number of cans	Dosage Megarad	Results of test
Pork Loin	10	11	4.5-5.6	neg[a]
	10	6	4.5-5.6	neg
	303	3	4.5-5.6	neg
Chicken, breast and thigh	10	21	4.5-5.6	neg
	3	26	4.5-5.6	neg
	3	1	2.5-3.2	neg
Ham roll, cured	10	1	1.5-1.9	neg
	10	13	2.5-3.2	neg
	10	1	2.5-3.2	neg
	10	4	4.5-5.6	neg
	10	7	4.5-5.6	neg
	3	15	4.5-5.6	neg
Beef, loin or round	10	1	4.5-5.6	neg
	3	1	4.5-5.6	neg
	3	25	4.5-5.6	neg
	3	1	6.0-7.5	neg

[a]After 72 hr all mice survived and showed no evidence of any toxic symptoms; mice were normal in appearance and behavior.

Results of the triangle tests using a laboratory panel to determine optimum cooking methods for irradiated meat indicated that browning irradiated meat in fat, adding the meat at the beginning of the cooking period, and the use of tomatoes and spices improved the quality of the products made with irradiated meat. Individuals preparing the recipes noticed rather strong and unpleasant odors during the browning of the radiation-sterilized meat.

The rating sheet used by the panel for indicating preference had only adjectives (see Figure 1).

Figure 1. Rating sheet for meat products.

Name_____ Date_____

Product_____

Show your reaction by checking on the line:

_____ Like extremely

_____ Like very much

_____ Like moderately

_____ Like slightly

_____ Neither like nor dislike

_____ Dislike slightly

_____ Dislike moderately

_____ Dislike very much

_____ Dislike extremely

- -

If you dislike the product, indicate the reason(s)

Lacks flavor_____ Too sour _____ Strong flavor _____

Other: _____

Comments:

Consumer panels of 40 students (approximately 20 men and 20 women) indicated their acceptance of the products made with non-irradiated or irradiated meat. Between December 1964, and December, 1965, 17 consumer panels evaluated 15 different products. Irradiated pork loin was tested in chop suey or barbeque; chicken in chop suey, barbeque and salad; ham slices with fruit sauce, with sweet and sour sauce, creamed, or in a sandwich with cheese; and beef in barbeque, in chili, or with gravy on noodles.

A total of 680 people were on the 17 panels, however, 202 individuals served on two or more panels so there were 478 different individuals. In all, 1860 judgments were made on products containing radiation sterilized meat and 1235 judgments on products containing non-irradiated meat.

The data on the rating sheets (Figure 1) were summarized by two methods for each product tested, namely, distribution of scores and average score. First a tally was made of the number of times each of the nine descriptive adjectives on the hedonic scale was checked. Then the frequency distribution was plotted for each product made with either the non-irradiated or the irradiated meat. The frequency distribution of consumer preferences for each of the 15 products are summarized in Tables 5-8. Arrangement of the data in this manner presents a clear picture of the exact number of each "step" on the hedonic scale. Also one can compare the acceptance at each level on the scale for non-irradiated meat or irradiated meat.

Table 5. Frequency distribution of consumer preferences[a] for chicken and pork in chop suey and barbeque.

Score	CHOP SUEY				BARBEQUE			
	Chicken		Pork		Chicken		Pork	
	Non-Irradiated	Irradiated	Non-Irradiated	Irradiated	Non-Irradiated	Irradiated	Non-Irradiated	Irradiated
Like extremely	9	17	5	13	21	27	11	35
Like very much	69	52	32	46	56	70	75	63
Like moderately	40	42	49	51	46	37	43	37
Like slightly	18	27	29	23	13	15	15	8
Neither like nor dislike	5	6	6	6	2	1	1	3
Dislike slightly	8	5	22	13	12	4	4	2
Dislike moderately	2	1	7	2	4	1	2	3
Dislike very much		1	3	1	1			
Dislike extremely			2					

[a]Panels 1-8, 306 consumers, December 1964 and January 1965.

Table 6. Frequency distribution of consumer preferences[a] for chicken salad and ham slices.

	Chicken Salad[b]			Ham Slices		
	Marinade			Non-irradiated[c]	Irradiated	
	None	Hot	Cold		Plain	Sauce
Like extremely	4	7	1	26	5	3
Like very much	40	10	19	63	38	30
Like moderately	45	40	46	25	26	35
Like slightly	20	27	23	7	18	16
Neither like nor dislike	6	16	9	1	14	6
Dislike slightly	4	13	19	2	17	20
Dislike moderately	3	6	7	1	5	9
Dislike very much	3	4	1	0	1	2
Dislike extremely	0	2	0	0	1	4

[a]Panels 9-11, 125 consumers, March and April 1965.

[b]Made from irradiated chicken

[c]Plain

Table 7. Frequency distribution of consumer preferences[a] for ham; creamed, in a sweet and sour sauce and in a sandwich.

Score	Creamed Ham Carolina		Sweet-Sour Ham		Montaug Sandwich	
	Non-irradiated	Irradiated	Non-irradiated	Irradiated	Non-irradiated	Irradiated
Like extremely	5	2	6	4	2	3
Like very much	26	18	30	25	25	19
Like moderately	22	24	24	25	27	25
Like slightly	12	15	14	13	15	16
Neither like nor dislike	5	6	4	5	2	8
Dislike slightly	10	13	2	10	5	7
Dislike moderately	2	3	5	4	2	0
Dislike very much	1	1	2	2	1	1
Dislike extremely	0	1	2	0	0	0
Total	83	83	88	88	79	79

[a]Panels 12-14, 125 consumers, October 1965.

Table 8. Frequency distribution of consumer preferences[a] for beef in barbecue, chili and beef with gravy on noodles

Score	Barbeque		Chili		Beef with gravy on noodles	
	Non-irradiated	Irradiated	Non-irradiated	Irradiated	Non-irradiated	Irradiated
Like extremely	10	10	2	2	2	3
Like very much	29	26	16	14	29	34
Like moderately	23	19	31	25	34	23
Like slightly	5	16	11	18	7	15
Neither like nor dislike	4	3	7	6	1	2
Dislike slightly	11	6	10	11	10	6
Dislike moderately		1	1	2	2	2
Dislike very much			2	1		
Dislike extremely			1	2		

[a]Panels 15-17, 124 consumers, December 1965.

On the other hand, there might be some advantage in obtaining an average score for each product so each level on the hedonic scale was assigned a numerical score with 9 = "like extremely" and 1 = "dislike extremely." Average score was calculated for each product and the results are summarized in Table 9. Most of the average scores would fall in the "like moderately" classification on the hedonic scale. In general, the products made with irradiated meats received average scores higher than or as high as those made with non-irradiated meat (Table 9).

For panels 1-8, the effects of sex of panel member and order of serving chop suey and barbeque at a taste panel session were considered. An analysis of variance was made to identify some of the factors that affected consumer acceptance or preference for the chop suey or the barbeque. The design used for the analysis was as follows:

Source of variation	d.f.
Order (O)	1
Sex (S)	1
Treatment (T)	1
O x S	1
O x T	1
S x T	1
O x S x T	1
Error	8

Order of serving (i.e. chop suey or barbeque first) was found to have a significant effect on scores for chop suey only; whereas, sex of panel member or kind of meat had no effect. The relatively bland chop suey was given lower ratings when served after barbequed meat than when served before the more spicy food.

Table 9. Summary of average acceptance scores of the 17 consumer panels for 15 products made with irradiated or non-irradiated meat.

Date		Panel no.	Total no. individuals	Product tested	Average score[1] Non-irradiated	Average score[1] Irradiated
1964	December	1-4	155	Pork Chop Suey	6.2	6.9
1965	January	5-8	151	Chicken Chop Suey	7.2	7.2
1964	December	1-4	155	Chicken Barbeque	7.1	7.6
1965	January	5-8	151	Pork Barbeque	7.4	7.7
1965	March-April	9-11	125	Ham Slices	7.8	6.4
				Ham Slices, fruit sauce		6.0
	March-April	9-11	125	Chicken Salad Cold Marinated		6.1
				Chicken Salad Hot Marinated		6.0
				Chicken Salad Not Marinated		6.8
	October	12,13	83	Creamed Ham Carolina	6.7	6.2
		12,14	79	Montaug Sandwich	6.8	6.6
		13,14	88	Sweet and Sour Ham	6.8	6.5
	December	15,17	82	Barbeque Beef	7.0	6.9
		15,16	85	Beef with Gravy on Noodles	6.8	6.9
		16,17	81	Chunk Chili	6.3	6.1

[1] 9= like extremely, 8= like very much, 7= like moderately, 6= like slightly

Consumers were encouraged to write comments on score cards and individuals preparing the products recorded their observations. A summary of the comments and observations follows.

1. Some noted that the recipes that contained radiation sterilized meats were "flat," "tasteless," or "too bland." However, some comments indicated that consumers preferred more salt or soy sauce i.e. the meat itself was not lacking in flavor. Often the same comments were made concerning recipes made with precooked non-irradiated meat.
2. For sweet-sour ham, consumer comments generally stated that the irradiated ham lacked typical flavor or that the flavor of the ham was not evident in the recipe. There were almost no comments on off-flavor. Thus, it may be assumed that the sauce masked any "irradiated" flavor in ham. The flavor of the sweet-sour sauce was "too strong" according to several consumer comments, whether the ham was irradiated or non-irradiated.
3. There were comments that irradiated ham on open face Montaug sandwiches was not typical in color and that it was dry or unattractive. However, the only off-flavor noted in irradiated ham was excessive saltiness. The majority of comments on the sandwich concerned cheese flavor, suggesting that the distinct flavor of sharp cheese was not appreciated by college student consumers.

4. Broiling irradiated ham slices increases the dryness of the product.
5. Marination of the ham slices before broiling results in a product that is more flavorful and moist than the plain broiled ham.
6. Cutting the irradiated ham into cubes of slices before cooking increases the surface area and allows for escape of the volatile off-flavors during subsequent heating.
7. In the open face sandwich, placing ham on top of the grated cheese for baking exposes the ham directly to the heat and assists in volatilizing the off-flavors. This is not the case when a slice of cheese is placed on top of the ham.
8. Cooking irradiated ham in a seasoned sauce or with other ingredients helps to moisten the ham which has a tendency to be dry. In addition, selection of the proper flavors for the sauce mask the off-flavor in the irradiated ham.
9. Some of the comments concerning Creamed Ham Carolina indicated that the product was given a relatively low rating because consumers disliked not the ham but mushrooms or hard cooked eggs.
10. Many consumers commented that the chicken salad that had been marinated was too sour or tart.

11. Some of the consumers stated that the Chunk Chili was too "hot" or too "spicy." This "spiciness" might explain the somewhat lower scores for Chunk Chili. Off-flavor in the irradiated meat was noted by only three consumers and one consumer commented that the non-irradiated beef had an off-flavor.

SUMMARY AND CONCLUSIONS

An investigation was conducted to determine the acceptability of irradiated pork loin, chicken breasts and thighs, cured smoked ham roll, and beef round or loin. A laboratory panel of 8-12 members was used to determine cooking procedures and in the development and selection of the final recipe submitted to the consumer panel. Consumer panels of approximately 40 members (20 men, 20 women) were selected from Iowa State University students. Seventeen panels were used to determine the acceptance of 15 products, however, each panel was given only 2 or 3 products.

At one test session the panel members received products made with non-irradiated meat and at the second session products made with irradiated meat were rated. A 9-point hedonic scale was used to determine the acceptance of the foods. A brief summary of the results obtained from 1860 judgments on irradiated meats follows.

1. Irradiated meat in Pork Chop Suey and Chicken or Pork Barbeque was more acceptable than non-irradiated meat in similar products.
2. The acceptability of Chicken Chop Suey was the same whether made with irradiated or non-irradiated meat.
3. Irradiated sliced ham was not as acceptable as non-irradiated ham served either plain or with fruit sauce.
4. Chicken salad made with irradiated chicken that had not been marinated was more acceptable than salad made with

irradiated chicken that had been treated with either a hot or cold marinade on the day prior to serving the salad.

5. Serving irradiated ham as sweet-sour ham or in a sandwich with cheese improved its acceptability compared to creamed ham or ham slices with fruit sauce.

6. Irradiated pork, chicken or beef in barbeque or chop suey rated highest in acceptability of the 15 products.

7. The average score for the 15 products arranged in order of acceptability were:

Pork Barbeque	Chicken Salad No Marinade	Creamed Ham Carolina
Chicken Barbeque	Montaug Sandwich (Ham)	Chicken Salad Cold Marinade
Chicken Chop Suey	Sweet-Sour Ham	Chunk Chili
Pork Chop Suey	Ham Slices	Chicken Salad Hot Marinade
Barbeque Beef		Ham Slices, Fruit Sauce
Beef and Gravy on Noodles		

8. Order of serving had a significant effect on acceptability of a food. When a spicy and a bland food were rated at the same test session, the bland food was given lower ratings when served after a spicy food than when served before the more spicy food.

9. Sex of panel member had no effect on acceptance of the meat products.

Under the conditions of this investigation in which 17 consumer panels composed of 367 men and 313 women indicated their preference for 15 products made with either irradiated or non-irradiated pork loin, chicken breasts and thighs, cured ham roll, or beef round or loin the following conclusions can be made:

1. Browning of irradiated meat in fat or long cooking tends to volatilize the objectionable odors caused by irradiation or in "warmed over" meat and improves the acceptability.
2. The use of onions, tomatoes, and spices in recipes containing irradiated or "warmed over" meat improves the flavor and makes the product more acceptable.
3. Irradiated pork loin, chicken, or beef is highly acceptable in barbeque, chop suey, or chili.
4. Irradiated ham could be improved.
5. Irradiated meats stored 6-7 months at room temperature have little or no typical radiation flavor and can be used in recipes for precooked meats.
6. The acceptance of irradiated meat is higher than or as high as non-irradiated meat in similar products.

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13. ABSTRACT

Recipes were developed and procedures standardized for 15 food products containing irradiated pork, chicken, cured ham, or beef. Seventeen consumer panels composed of both men and women (1860 judgments) were employed to determine the acceptance of the irradiated meat products compared to similar products made with non-irradiated, precooked meat. It was found that browning irradiated meat in fat or long cooking with the other ingredients in the recipe reduced the "irradiation flavor." The use of onions, tomatoes, and spices enhanced the somewhat bland flavor of "warmed-over" meat.

Irradiated pork or chicken chop suey and pork, beef, or chicken cooked in barbeque sauce were highly acceptable and rated higher or as high in acceptability as non-irradiated meat in similar products. All 15 meat products tested received average acceptability scores of from 6.0 to 7.7 on a 9-point hedonic scale (9 = "like extremely"). Both trained laboratory panels and consumer panels were used to determine the effect of the various factors on the acceptance of the irradiated meat.

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Seasonings			6			
Tomatoes			6			
Acceptability			7			